

Appl. No. 10/627,507
Amdt. dated March 17, 2006
Reply to Office Action of December 15, 2005

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Amendments to the Claims:

This listing of claims will replace all prior versions, and listings of claims in the application:

Listing of Claims:

1-16. (Canceled)

17. (Currently amended): A method for processing data in a ~~data-store~~
storage system coupled to a host computer via a network, the method comprising:
producing ~~one or more~~ snapshots of a data store volume, including a first snapshot
of at least a portion of the data volume for a first point in time and a second snapshot of the
portion of the data volume for a second point in time, wherein the first point in time is
represented by first information that specifies a time when the first snapshot is taken and the
second point in time is represented by second information that specifies a time when the second
snapshot is taken;
detecting write requests directed to the data store volume and in response thereto
producing journal entries corresponding to the write requests, wherein at least one of the journal
entries can be applied to one of the snapshots to recreate ~~one or more data states~~ data of the
portion of the data store volume, wherein the journal entries includes write data associated with
the write requests and time ordering information that specifies order of the write requests made
to the data volume;
detecting a marker request and in response thereto producing a marker journal
entry that specifies a third point in time between the first point in time and the second point in
time, wherein the journal entries and the marker journal entry are ordered according to the a time
when one of the ~~of their respective~~ write requests is conducted and the third point in time marker
requests;
detecting a request to retrieve a ~~specified~~ the marker journal entry that specifies
the third point in time between the first point in time and the second point in time and in
response thereto accessing the specified marker journal entry; and

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detecting a request to perform a recovery operation, the request including ~~a target~~
the third point in time ~~based on a time~~ associated with a ~~previously retrieved~~ the marker journal
entry, and in response thereto:

selecting one of the first or second snapshot based on the first information,
the second information, and the third point in time; and

selecting at least one of the journal entries corresponding to the write
operation conducted between the third point in time and one of the first or second point in
time associated with the selected snapshot based on one of the first or second information
associated with the selected snapshot, the time ordering information and the third point in
time to recover data of the portion of the data volume at the third point in time by using
the selected snapshot and the selected at least one of the journal entries.

18-30. (Canceled)

31. (New): A storage system coupled to a host computer via a network
comprising:
a data volume storing write data from the host computer;
a snapshot storing area storing a first snapshot of at least a portion of the data
volume for a first point in time, the first point in time represented by first information that
specifies a time when the first snapshot is taken, the snapshot storing area further storing a
second snapshot of the portion of the data volume for a second point in time, the second point in
time represented by second information that specifies a time when the second snapshot is taken;
a journal storing area storing journal entries, wherein the journal entries comprises
the write data and time ordering information that specifies order of write operations made to the
data volume, and storing marker information that specifies a third point in time between the first
point in time and the second point in time; and
a storage controller configured to perform write operations according to write
requests received from the host computer, to manage snapshot operations to store a plurality of
snapshots including the first snapshot and the second snapshot, and to manage journal operations

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16 to record the journal entries and record the marker information based on an instruction from the
17 host computer;

18 wherein the first information, the second information, and the marker information
19 are associated with the time ordering information to specify time ordering among a time when
20 one of the write operations is conducted, the first point in time, the second point in time, and the
21 third point in time,

22 wherein the storage controller releases at least one of the stored journal entries,
23 wherein, in response to receiving a data recovery request that includes the marker
24 information between the first point in time and the second point in time, the storage controller
25 determines if at least one of the journal entries is stored in the journal storing area to perform the
26 data recovery request,

27 wherein, in response to the data recovery request, the storage controller selects
28 one of either the first or second snapshot based on the first information, the second information,
29 and the marker information, and selects at least one of the journal entries corresponding to the
30 write operation conducted between the third point in time and one of the first or second point in
31 time associated with the selected snapshot, based on one of: the first or second information
32 associated with the selected snapshot, the time ordering information and the marker information
33 to recover data of the portion of the data volume at the third point in time by using
34 the selected snapshot and the selected at least one of the journal entries.

1 32. (New): The storage system of claim 31, wherein the time ordering
2 information includes time information and/or sequence number.

1 33. (New): The storage system of claim 32, wherein the first and second
2 information include time information and/or sequence number.

1 34. (New): The storage system of claim 33, wherein the marker information
2 include time information and/or sequence number.

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1 35. (New): The storage system of claim 31, wherein the write data stored in
2 the journal storing area are stored in chronological order.

1 36. (New): The storage system of claim 31, wherein the snapshot storing area
2 and/or the journal storing area are configured with storage volumes.

1 37. (New): The storage system of claim 31, wherein at least one of the journal
2 entries are stored in the journal storing area before storing one of the plurality of snapshots in the
3 snapshot storing area.

1 38. (New): The storage system of claim 31, wherein the journal operations
2 are started prior to starting the snapshot operations.

1 39. (New): The storage system of claim 31, wherein the selected snapshot is
2 closest in time to the third point in time.

1 40. (New): The storage system of claim 31, wherein the selected snapshot is
2 prior in time to the third point in time.

1 41. (New): The storage system of claim 31, wherein when receiving a data
2 recovery request with target time between the first point in time and the second point in time, the
3 storage controller selects one of the first or second snapshot based on the first information, the
4 second information, and the target time, and selects at least one of the journal entries
5 corresponding to the write operation conducted between the target time and one of the first or
6 second point in time associated with the selected snapshot based on one of the first or second
7 information associated with the selected snapshot, the time ordering information and the target
8 time to recover data of the portion of the data volume at the target time by using the selected
9 snapshot and the selected at least one of the journal entries.

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1 42. (New): A storage system coupled to a host computer via a network
2 comprising:
3 a data volume storing write data from the host computer;
4 a snapshot storing area storing a first snapshot of at least a portion of the data
5 volume for a first point in time, the first point in time represented by first information that
6 specifies a time when the first snapshot is taken, the snapshot storing area further storing a
7 second snapshot of the portion of the data volume for a second point in time, the second point in
8 time represented by second information that specifies a time when the second snapshot is taken;
9 a journal storing area storing journal entries and marker information, wherein the
10 journal entries comprises the write data and sequence numbers that specifies write ordering to the
11 data volume; and
12 a storage controller conducting write operations according to write requests from
13 the host computer, managing snapshot operations to store a plurality of snapshots including the
14 first snapshot and the second snapshot, and managing journal operations to record the journal
15 entries and record the marker information based on an instruction from the host computer;
16 wherein the sequence number is associated with the first information, the second
17 information, and the marker information;
18 wherein the storage controller releases at least one of the stored journal entries,
19 wherein when receiving a data recovery request that includes the marker
20 information between the first point in time and the second point in time, the storage controller
21 determines if at least one of the journal entries is stored in the journal storing area to perform the
22 data recovery request, selects one of the first or second snapshot based on the first information,
23 the second information and the marker information to copy the selected snapshot to a recovery
24 volume, and selects at least one of the journal entries based on one of the first or second
25 information associated with the selected snapshot, the sequence number and the marker
26 information to recover data of the portion of the data volume by applying the selected journal
27 entries to the copied snapshot in the recovery volume.

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1 43. (New): The storage system of claim 42, wherein when receiving a data
2 recovery request with a first target time between the first point in time and the second point in
3 time, the storage controller selects one of the first or second snapshot based on the first
4 information, the second information and the first target time to copy the selected snapshot to a
5 recovery volume, and selects at least one of the journal entries based on one of the first or second
6 information associated with the selected snapshot, the sequence number and the first target time
7 to recover data of the portion of the data volume at the first target time by applying the selected
8 journal entries to the copied snapshot in the recovery volume.

1 44. (New): The storage system of claim 42, wherein when receiving a data
2 recovery request with a second target time between the first point in time and the second point in
3 time, the storage controller selects one of the first or second snapshot based on the first
4 information, the second information and the second target time to copy the selected snapshot to a
5 recovery volume, and selects at least one of the journal entries based on one of the first or second
6 information associated with the selected snapshot, the sequence number and the second target
7 time to recover data of the portion of the data volume at the second target time by applying the
8 selected journal entries to the selected snapshot in the recovery volume.

1 45. (New): The storage system of claim 42, wherein the write data stored in
2 the journal storing area are stored in chronological order.

1 46. (New): The storage system of claim 42, wherein the snapshot storing area
2 and/or the journal storing area are configured with storage volumes.